Manure Management (Mania)

Another Technical Review

John D. Ewing, P.E.
Environmental Systems & Solutions, LLC

Current Technologies

- Commonly Found
  - Plug Flow
  - Complete Mix
  - Covered Lagoon
- Less Common or Emerging
  - Fixed Film
  - Hybrids
  - Upright Cylinder

Back to Basics

- What is the mission of manure handling w/o energy recovery?
  1. Get it out of the parlor and barn efficiently
  2. Contain it
  3. Minimize odor if near a non agricultural population
  4. Get the nutrients back where they belong
  5. Get the bedding (fiber/sand) back where it belongs

Back to Basics

- What is the mission of manure handling w/ energy recovery?
  1. Don’t break the bank or die trying
  2. Select a reliable digestion system
  3. Fully utilize the energy benefit
  4. Fully utilize the product recovery benefit
  5. Have the option to maximize energy production

Back to Basics

- What are the three fundamental characteristics of manure?

1. Strainable Components – The 3 R's (rocks, rope, rags, etc.)
2. Floatable Components (Floaters)
3. Settling Components (Sinkers)
4. Liquid Components (Suspended and Colloidals)

Back to Basics

- Appropriate Initial Handling is Critical to Success of Every Digester Concept
  - Coarse screening (1”) required for all systems
  - Medium screening (1/2”) beneficial to all systems
  - Settling zone required for all systems
  - Fiber separation optional for most and required for fixed film
  - Holding, mixing and conditioning beneficial for all systems

Back to Basics

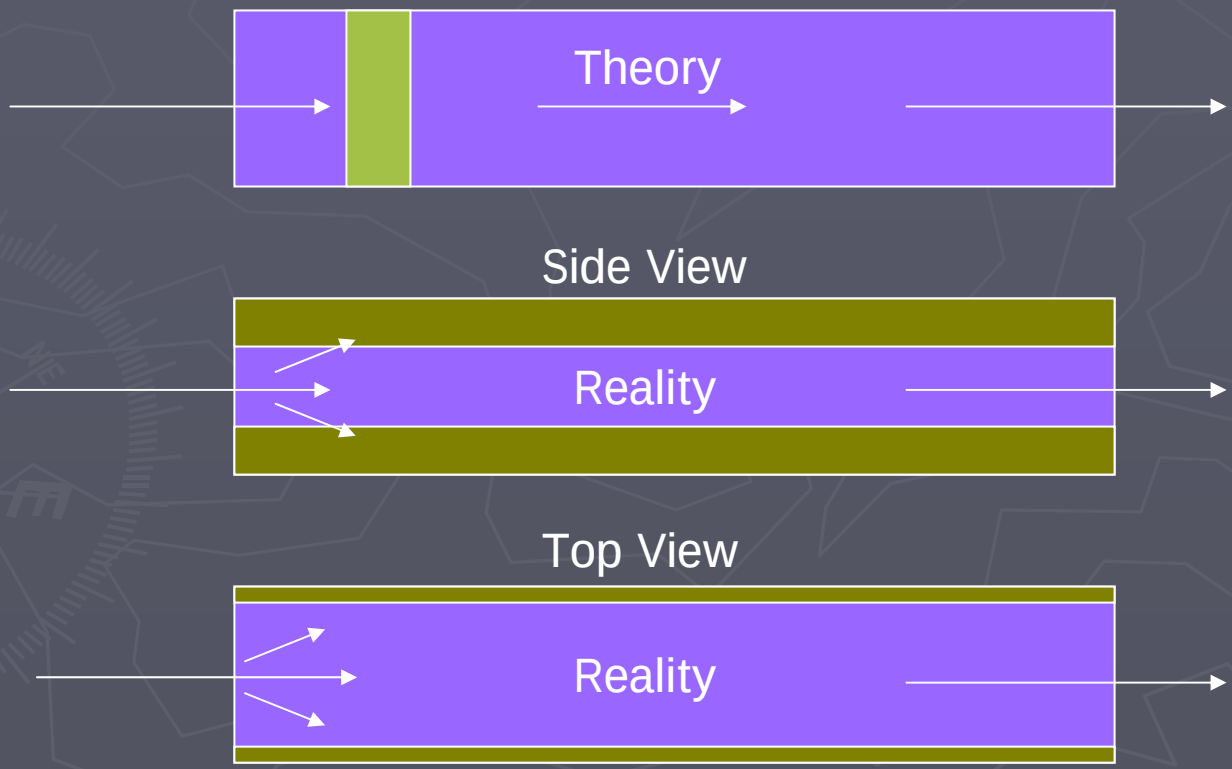
- There are some paradigms associated with digester technologies and component separation issues
  - Plug Flow proponents claim this separation is minimized
  - Complete mix proponents claim this separation is minimized
  - Fixed Film proponents claim this separation is minimized
  - Hybrid proponents claim this separation is minimized

Back to Basics

- Plug Flow
  - It is not if but when a plug flow digester will require complete cleaning
  - The surface layer of fiber forms immediately and continues to grow over time.
  - Bottom deposition begins immediately and continues to grow over time

Plug Flow Dynamics

Theory is that mass moves as ‘uniform’ plug; Reality is that mass separates and leads to very large very expensive conservative designs that still work nearly as well when over 30% of the volume is inactive

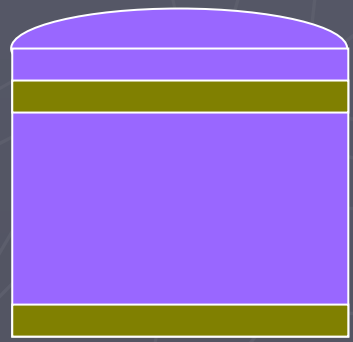


Complete Mix Dynamics

Theory is that uniform mixing provides higher rate and more complete volatile solids reduction while minimizing separation.

Reality is that large footprint design is leads to high mechanical energy requirement for mixing and very rapid separation when shut off. Resuspension and reblending of the layers is difficult if not impossible with typical energy input thereby yielding an inherent inefficiency.

Theory



Reality

Covered Lagoon Dynamics

Covered Lagoons are not dynamic but are by far the simplest and often the most cost effective approach to manure handling

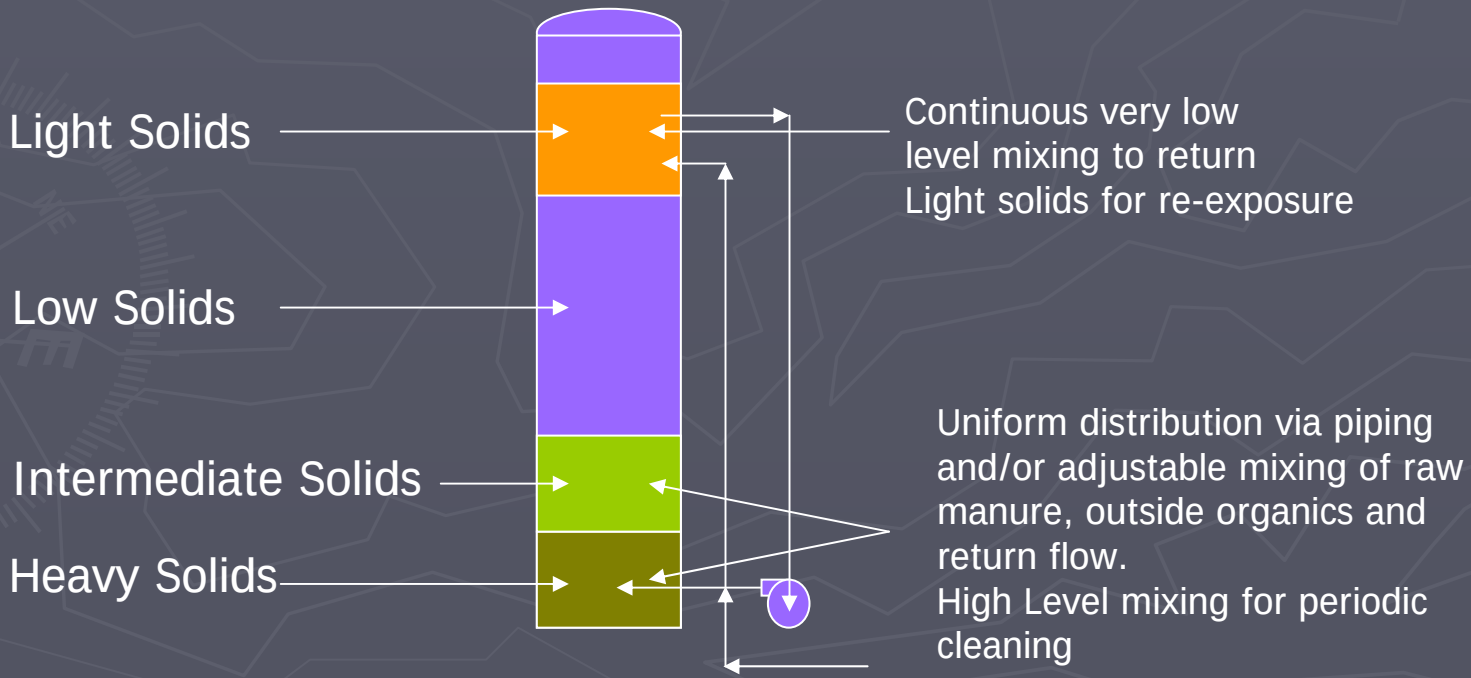
- Land must be inexpensive
- Requires minimal exposure to cold temperatures.
- They are very large and ‘very slow’ but if it doesn’t matter, a covered lagoon will generally be the best long term value as long as a quality system is purchased and installed correctly.
- A multicell approach is more costly but more reliable
- Custom engineered mixing and heating is feasible for better efficiency when excess heat is not used elsewhere on the site.

Fixed Film Dynamics

- Due to the dilute and well screened nature of the material fed to a fixed film reactor, separation issues are significantly reduced.
- The inherent negative issues with fixed film is the dilute (.5-1% solids) required to function effectively without plugging.
- The higher water volume leads to much larger heating demands and pumping requirements.
- The system is expensive and cleaning is difficult when required due to the media
- On the positive side, the pumps are generally more reliable and operate more efficiently
- Sand bedding issues can be minimized because sand is easy to separate from dilute manure

Upright Cylinder Digester

- The upright cylinder design (UCD) is a relatively new/emerging approach. Also being called an induced bed reactor (IBR). Patents applied for.
- The UCD is a cross between complete mix and plug flow
- The unique characteristics of the design tend to mitigate many of the disadvantages of both PF and CM designs



Upright Cylinder Digester

UCD Advantages Include

1. Short liquid detention (5 days or less)
2. Modularity
   - Minimizes initial capital
   - Allows sequential expansion
   - Fits more naturally into the farm environment (silo appearance)
   - More Adaptable to small farm environments
   - Short construction time due to minimal infrastructure
3. Adaptability to all bedding systems
4. Variable solids compatibility in raw material
5. Design leverages the natural separation characteristics of manure to improve efficiency
6. Design enhances opportunity for significant co-digestion of outside organic materials which often dramatically improves the economics
7. Design facilitates the addition of macro and micronutrients for optimal performance
8. Non generation related costs appear to have one the lowest unit costs/cow (<$300/cow)

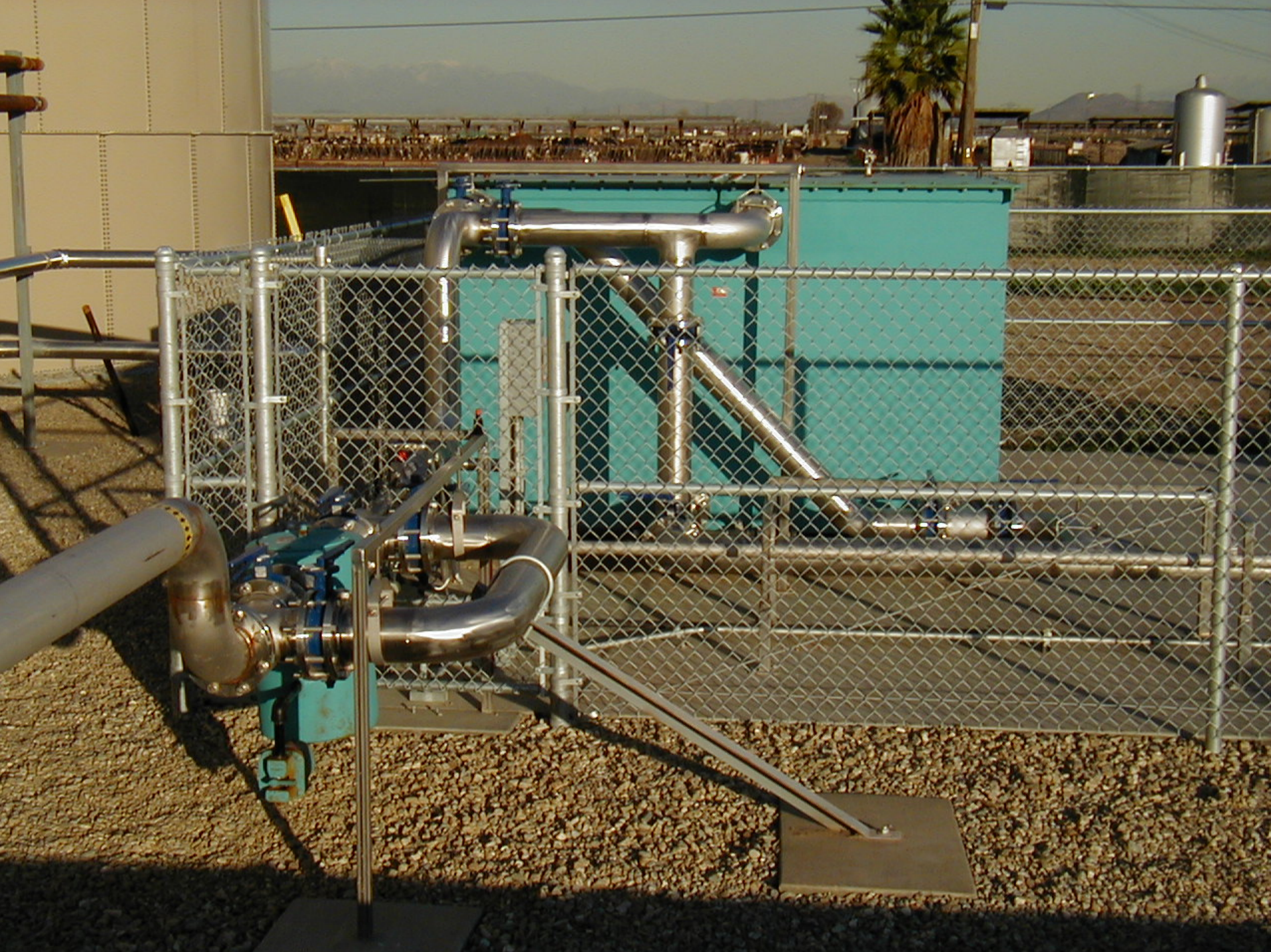
Upright Cylinder Digester

UCD Disadvantages

1. More mechanical equipment and piping
2. More sensors and controls
3. More valves and fittings
4. Less full scale operational experience
5. In the case of the IBR approach the tanks are enclosed in a building which leads to several potential issues

Summary

- Manure digester systems are in need of continued attention in order that future systems are more reliable, flexible and economical than those predominantly used today.
- Utility interconnection issues and payback options must be straightened out so that more farming regions can benefit from the distributed energy generation concept.
- In my opinion the UCD approach holds the most promise to improve the technical and economic viability of on farm digesters.




PIONEER